

## Claims

We claim:

- 1 1. A method for decoding a received word for a finite geometry code, comprising:  
2 a one-time initialization procedure; comprising:  
3 defining a parity check matrix for the finite geometry code;  
4 representing each bit in the received word by an element, each  
5 element having either a zero, one or uncertain value; and  
6 an iterative decoding procedure, comprising:  
7 terminating when a termination condition is true, and otherwise:  
8 determining a set of votes for each element depending on the parity  
9 check matrix and current values of the elements;  
10 updating the elements based on the set of votes for each element and  
11 the received word.
- 1 2. The method of claim 1, in which the parity check matrix representing an  $(N, k)$   
2 finite geometry code has  $M$  rows and  $N$  columns and rank  $N-k$ , and the  $M$  rows are  
3 incidence vectors of a set of selected  $\mu$ -flats in the finite geometry with respect to  
4  $N$  points of the finite geometry, each row containing  $J$  ones and  $N-J$  zeros.
- 1 3. The method of claim 1, in which the  $\mu$ -flats are cyclic shifts of each other.
- 1 4. The method of claim 1, in which each of the elements express a state of the  
2 decoder corresponding to a bit of the received word, and the termination condition  
3 is satisfied when the state of the decoder is a code-word.

1 5. The method of claim 1, in which the initialization procedure and the decoding  
2 procedure are restarted with a substantially larger parity check matrix if the  
3 termination condition is satisfied and the state of the decoder does not correspond  
4 to a code-word.

1 6. The method of claim 1, in which each row of the parity check matrix  
2 corresponds to a parity check, and each parity check sends votes to  $J$  elements,  
3 where the elements that a parity check sends a vote to correspond to the columns of  
4 the parity check matrix that have the value 1 in a row corresponding to the parity  
5 check.

1 7. The method of claim 6, in which the vote for a particular parity check to a  
2 particular element is determined by states of the  $J-1$  other elements associated with  
3 the parity check.

1 8. The method of claim 6, in which the vote from a particular parity check to a  
2 particular element is an abstention if any of the  $J-1$  other elements associated with  
3 the parity check has the uncertain value, and is one when the number of other  
4 elements associated with the parity check having a value of one is odd, and is zero  
5 otherwise.

1 9. The method of claim 6, further comprising:  
2 determining a recommendation and strength of recommendation for each  
3 element from the associated parity checks that send a vote to it.

- 1 10. The method of claim 9, in which the recommendation is zero when a majority  
2 of the votes are zero, the recommendation is one when the majority of the votes are  
3 one, and there is no recommendation when the zero and one votes are equal.
- 1 11. The method of claim 10, in which the strength of the recommendation is a  
2 magnitude of a difference between the number of zero votes and the number of one  
3 votes.
- 1 12. The method of claim 11, in which the votes determine a next updated state of a  
2 particular element by means of a comparison of the strength of the  
3 recommendation of the parity checks with a threshold  $b_{flip}$  and a threshold  $b_{uncertain}$ .
- 1 13. The method of claim 12, in which the next updated state of a particular element  
2 is equal to a value in the received word if the recommendation of the parity checks  
3 agrees with the value in the received word.
- 1 14. The method of claim 12, in which the next updated state of a particular element  
2 is equal to a value in the received word if the recommendation of the parity checks  
3 is not equal to the value in the received word, and the strength of the  
4 recommendation is less than the threshold  $b_{uncertain}$ , and the next updated state of  
5 the particular element is a state representing uncertainty if the recommendation of  
6 the parity checks is not equal to the value in the received word, and the strength of  
7 the recommendation is greater than or equal to the threshold  $b_{uncertain}$ , and less than  
8 the threshold  $b_{flip}$ , and the next updated state of the particular element agree with  
9 the recommendation of the parity checks if the strength of the recommendation is  
10 greater than the threshold  $b_{flip}$ .

- 1 15. The method of claim 12 further comprising:
- 2       updating the values of the thresholds at an end of each decoding cycle,
- 3       according to a pre-determined schedule.